Trench Composting Of Animal (Dairy) Mortalities
An Emergency Response To A Catastrophic Barn Fire

Jeffrey G. Comstock, Soil Scientist

Vermont Agency of Agriculture, Food & Markets

116 State Street, Montpelier, VT 05620 jeff.comstock@state.vt.us

David L. Weber, M.S., Agricultural Water Quality Specialist

Vermont Agency of Agriculture, Food & Markets

116 State Street, Montpelier, VT 05620

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Abstract. *The Vermont Agency of Agriculture conducted a large scale trench composting project for animal mortalities as an emergency response to a catastrophic barn fire on a dairy farm in Swanton, Vermont during May, 2008. The Agency acted as the incident commander and site supervisor for the siting, excavation and construction of the compost pile for approximately 130 burned dairy cows.*

Long-term temperature monitoring was conducted during the 2008 crop growing season. Collection of multi-depth temperature data resumed during the Spring of 2009. At Week 52, test pits were excavated to inspect the interior of the compost trench to evaluate the effectiveness of the technique before making a decision about returning management of the site to the landowner for use as crop land.

The emergency management component of this project was successful. The containment and disposal of the animal carcasses was accomplished within three days and the compost trench remained intact without being disturbed by scavengers, emitting odors or releasing leachate

The composting component of this project did not perform as anticipated. Temperature data indicated interior depths of the trench did not reach optimal composting temperatures. Poorly

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designed surface drainage created a lack of aeration, resulting in poor composting performance. Inspection of the excavated test pits in May, 2009 confirmed incomplete composting of the animal carcasses.

The Agency has identified necessary modifications to the State of Vermont emergency response procedures and will utilize a revised practice for future emergency disposal of a large number of animal mortalities where composting is appropriate.

Keywords. Trench composting - Animal mortalities – Emergency mortality response

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Introduction

The on-farm disposal of animal carcasses is a reality of farm management that represents two different need scenarios: the ongoing practice of disposing of small numbers of individual mortalities that occur on a routine basis as the result of age, accident or infection; and emergency situations that require the disposal of large numbers of animals at one time from disasters such as floods, fires, roof collapses or disease outbreaks.

For routine carcass management, the common practices of burial or above ground stacking at remote area sites are gradually being replaced by composting techniques. The farm management, public health and regulatory factors that drive this trend are primarily odor and nuisance control (of insects and scavengers), water quality protection and the containment and prevention of disease transmission. Composting mortalities also allows a farm to return nutrients from composted carcasses back to the crop production side of an enterprise and provides a more practical and sustainable option for a farm that cannot rely on a rendering service for disposal because the availability of rendering operations is limited in many geographic areas (CWMI, 2002).

As more farms expand herd and flock size, it is imperative that states have adequate emergency mortality response plans that will sufficiently address the public health and environmental concerns associated with catastrophic events (Cooper, 2008). This project provided the Vermont Agency of Agriculture with a clear challenge. It created an opportunity and highlighted the need for the Agency to structure an emergency response program that will provide farmers and the public a well defined carcass management plan to deal with large scale animal mortality and disease events in the future (Haas, 2009).

Project Scope and Site Design

The scope of the project reported here is the utilization and evaluation of a trench composting practice/technique employed as an emergency response to a barn fire that killed 130 mature dairy cows on a farm in Swanton, Vermont during May, 2008.

Day #1 - The Vermont Agency of Agriculture was notified that the fire occurred during the overnight hours and that assistance was requested. Day 1 was spent on planning and preparation by Agency staff, while demolition crews at the farm worked to remove building debris and gain access to the burned animals. Farm site maps and soil survey map characteristics were prepared and evaluated for selecting potential burial or composting sites. Staff engineers provided estimates for the size of composting/burial site capacity. An alternative for off-site disposal at a solid waste management facility (SWMF) was also explored and the cost estimates evaluated.

Although the cost estimate for SWMF disposal appeared favorable, the on-site disposal option was selected based on; a long travel distance to the SWMF, the capacity of the available trucks for transport and the number of trips and trucks that would be required. The Agency was also concerned about the potential level of containment the SWMF transfer trucks could guarantee while passing through many towns during the long transportation distance. The Agency determined the public relations situation could not afford to risk leaking trucks leaving the site or traveling long distances between the farm and the SWMF.

After a discussion of all plausible options and consultation with the state Department of Environmental Conservation (DEC), which is the state's primary solid waste authority, it was determined that transporting the large amount of carcass material off-site could not be done in a way that sufficiently protected public health. The Agency of Agriculture was then tasked with determining how to dispose of the carcasses on-site while minimizing any pathogenic, odor, or other environmental impacts that could affect surface and ground water resources.

Site Selection

Day #2 – Agency staff arrived at the farm and met with the farm operator (leased operator) and the landowner. Agency animal health and water quality staff included the state Veterinarian, an animal health inspector, a nutrient management specialist, a soil and water quality monitoring specialist and the Deputy Secretary.

The decision-making process to select an on-farm disposal site was not a straight forward endeavor. The initial intention of the farm operator was to bury all the animals. The animal health staff and the Deputy Secretary informed the farm operator and the landowner that the burial option was not practical or satisfactory. The combination of soil conditions at the farm and the required capacity of a pit could not meet regulatory requirements for burial (Table 1). A field site for above ground composting was identified by the water quality staff that met the State of Vermont Accepted Agricultural Practices (AAP) requirements for mortality management and manure stacking criteria. The farm operator objected to the proposed field site because it was located in the middle of a crop field. A secondary site at the field perimeter was identified and agreed to in response to the farm request to accommodate field planting plans for the upcoming cropping season.

Table 1. Vermont Regulatory Criteria for Burial or Composting of Animal Carcasses/Mortalities.

Vermont - Compost & Burial Site Criteria For Animal Mortalities			
Solid Waste Regulations Environmental Conservation	**Accepted Agricultural Practices Rules Agency of Agriculture**		
Burial: On Farm Property	**Burial:** On Farm Property	**Composting:** On Farm Property	**Manure Stacking:** Winter Spreading Prohibition
150 feet to property lines, wells & surface waters	150 feet to property lines, wells & surface waters	100 feet to property lines, wells & surface waters	A or B Slope Soils (Less than 8%) Permeability < 2 in/hr
3 feet above seasonal high water table	3 feet above seasonal high water table	300 feet to neighboring domiciles	2 feet above water table
6 feet above bedrock		Not on land subject to annual flooding	4 feet above bedrock
24 inches of soil cover	24 inches of soil cover		Not on land subject to frequent flooding

The decision to incorporate the shallow trench concept into the construction of the compost pile rather than an above ground compost windrow was made to accommodate the concern expressed by the Department of Environmental Conservation (DEC) that the compost site must contain the runoff of any nutrient or pathogen laden leachate.

The site selected was approximately 700ft (215m) from the farmstead and the nearest residence and 300ft (92m) from field drainage ditches. The soil characteristics of the site were identified using USDA-NRCS soil survey map units for Franklin County, Vermont. The soils were identified as Massena (MeA) and Scantic (ScA). These soils are stony loam and silt loam, respectively. Both of these map units are classified as Hydrologic Group C soils. More importantly, with soil depths of 40-44 in. (102-112 cm) and permeability of less than 2 in/hr (A horizon) and less than 0.6 in/hr (B & C horizons), the site was well suited for an above ground composting site.

Although these soils often have seasonal perched water tables, leaching to groundwater was not considered a risk because of the low permeability characteristics. Soil cores taken during the search for a field site confirmed the absence of a high water table. It was also confirmed there were no public water supplies in the area and the nearest private well was 700 ft (213m) away.

Trench Construction

Based on an initial estimate of 250 animals, a trench perimeter with dimensions of 250 ft X 20 ft (76m X 6m) was staked out. The trench was excavated to a depth of approximately 2 ft (60cm). A base layer that was a mixture of dried bedded pack from a maternity barn and methane digester solids was spread in the bottom of the trench at target thickness of 1 ft (30cm). The base layer of approximately 4,100 ft^3 ($115m^3$) was spread in the first 200 ft (61m) of the trench.

Animal carcasses were transported from the barn in the back of a demolition contractor salvage truck and arranged on top of the bedding material as a single layer with the bucket arm of small excavator. The standard composting practice of lancing the rumen was not required due to the deteriorating and broken condition of the animal carcasses. At the conclusion of Day 2, all mortalities had been transported and placed in the trench. The actual number of animals on site was confirmed to be 130, not the originally reported estimate of 250. Therefore, carcasses only occupied the first 175 ft (53m) of the trench. The animal filled trench was left uncovered overnight

Day #3 -The carcasses in the trench were covered with approximately 1 ft (30cm) of organic activator material. The only material available on the farm was the spoiled waste feed from a corn silage bunker and material left over from improperly disposed pig manure and bedding. This material was less than ideal because much of it was already composted and cross contaminated with plastic bale wrap, split tires, animal carcass parts, rubber floor mat fragments and assorted other non-compostable materials.

The trench was filled with the activator layer material to a height even with ground level. The entire trench was covered with approximately 6,500 ft^3 ($184m^3$) of the same bedding material used as the base layer in the bottom of the trench below the carcasses. The bedding material used as the base layer and the top cover was delivered from another farm in the area approximately 10 miles away. The height of the finished pile was approximately 2-3 ft (1m) above ground level with dimensions of 175 X 20 ft (53m X 6m) or 3,500 ft^2 ($325m^2$). The compost trench was completed at the end of Day 3. This concluded the emergency response phase of the project.

Day #14 – After completion of the original compost trench, farm staff filled the remaining 75 ft (23m) of unused trench with additional waste feed material in an effort to clean up the rest of the silage bunker area. The Agency of Agriculture sent written instructions to the land owner and the farm operator requiring the additional waste material be covered with a top layer of bedding as was done for the rest of the compost trench. In response to that requirement, an additional 5,700 ft^3 ($161m^3$) of cover material was placed over the open end of the trench and as a second layer of top cover for the remainder of the trench.

Results

Temperature Monitoring

Temperature monitoring of the compost trench was initiated at Week 2 after initial construction and continued bi-weekly for three (3) months (May-August) and then monthly for three (3) months (Sept-Nov). Bi-weekly temperature monitoring for six weeks was resumed in April, 2009. The temperature monitoring schedule and the corresponding calendar dates are presented in Table 2. Temperature data was recorded at 1 ft increments. Temperature data was recorded using a REOTEMP Heavy Duty Windrow Thermometer with a 3 ft. X 5/16 in. probe. Temperature data at depths deeper than 3 feet was obtained by digging a hole 2 feet deep in the top of the pile to access the materials deeper than 3 feet. Holes in the compost cover material were refilled after sampling. At each sampling date, an attempt was made to probe a previously undisturbed section of the pile at each of the four (4) monitoring sites.

The initial site visit at Week 2 had three (3) monitoring sites that covered the original compost pile. Site 4 was added at Week 4 after the additional pile was covered with a top layer of composted bedding. It should be noted that sites 1, 2 & 3 represent composting carcasses and site 4 only has waste feed material with no animals present. The temperature monitoring sites started at the east end of the trench with Site 1 at approximately 20 ft (6m), Site 2 at 55 ft (17m), Site 3 at 105 ft (32m) and Site 4 at 200 ft (60m).

Table 2. Temperature Monitoring Schedule for 2008 – 2009.

2008											2009		
Wk #2	Wk #3	Wk #4	Wk #6	Wk #8	Wk #10	Wk #12	Wk #14	Wk #18	Wk #22	Wk #25	Wk #47	Wk #49	Wk #52
28May	6Jun	13Jun	27Jun	11Jul	25Jul	7Aug	21Aug	19Sep	17Oct	7Nov	8Apr	24Apr	15May

The temperature monitoring data for Sites 1-4 is presented in Table 3. The corresponding graphs of the temperature data for Sites 1-4 are presented in Figure 1.

Table 3. Temperature Monitoring Data for Sites 1-4. (*Data in Degrees Celsius)*

Site #1	2008											2009		
Depth (ft)	Wk #2	Wk #3	Wk #4	Wk #6	Wk #8	Wk #10	Wk #12	Wk #14	Wk #18	Wk #22	Wk #25	Wk #47	Wk #49	Wk #52
1 ft	60.0	57.8	60.0	62.2	59.4	54.4	55.6	60.6	57.8	50.6	50.0	28.3	26.1	34.4
2 ft	65.6	52.2	59.4	62.8	55.6	55.6	56.1	56.1	57.2	51.1	51.1	29.4	28.3	31.7
3 ft	40.0	47.8	59.4	57.8	46.7	48.9	48.9	51.1	49.4	46.7	48.3	27.2	26.7	26.1
4 ft		52.2	56.7	50.6	45.6	40.0	40.0	45.6	40.6	38.3	41.7	23.3	21.1	22.2
5 ft		49.4	46.7	45.6	43.3	25.6	35.6	42.2		34.4		20.0	20.0	20.0

Site #2	2008											2009		
Depth (ft)	Wk #2	Wk #3	Wk #4	Wk #6	Wk #8	Wk #10	Wk #12	Wk #14	Wk #18	Wk #22	Wk #25	Wk #47	Wk #49	Wk #52
1 ft	61.1	50.0	58.3	56.1	62.2	58.9	58.3	53.9	48.3	50.6	49.4	7.2	9.4	13.3
2 ft		49.4	54.4	53.9	59.4	55.0	53.9	50.0	46.1	47.2	47.8	7.8	8.9	12.8
3 ft	41.1	45.6	47.2	50.0	50.0	47.2	47.8	48.9	43.9	40.6	45.0	8.9	8.9	11.1
4 ft		46.7	36.7	43.3	46.7	42.2	42.2	43.3	38.3	34.4		10.0	9.4	11.1
5 ft		43.3	29.4		40.0							11.1		

Table 3. cont

Site #3	2008											2009		
Depth (ft)	Wk #2	Wk #3	Wk #4	Wk #6	Wk #8	Wk #10	Wk #12	Wk #14	Wk #18	Wk #22	Wk #25	Wk #47	Wk #49	Wk #52
1 ft	60.0	56.7	57.8	61.1	63.3	52.2	52.8	57.2	55.6		37.8	7.8	9.4	12.8
2 ft	54.4	51.7	52.2	54.4	62.8	50.0	48.3	51.1	50.0		37.8	7.8	8.9	12.2
3 ft	36.7	52.2	43.9	46.1	54.4	41.1	43.3	43.9	47.8		37.8	8.3	8.3	11.1
4 ft		45.6	37.2	41.1	51.1	33.3	31.1	33.3	37.8			10.0	9.4	10.0
5 ft		39.4	36.1	31.7	37.8			31.1					10.0	

Site #4	2008											2009		
Depth (ft)	Wk #2	Wk #3	Wk #4	Wk #6	Wk #8	Wk #10	Wk #12	Wk #14	Wk #18	Wk #22	Wk #25	Wk #47	Wk #49	Wk #52
1 ft		49.4	61.1	53.3	60.0	53.3	51.1	51.1	57.2		39.4	6.7	8.9	12.8
2 ft		41.1	58.3	46.7	55.0	46.7	46.7	46.7	52.2		46.1	7.2	7.8	11.1
3 ft		31.7	48.3	38.3	47.8	40.0	39.4	40.0	45.0		42.2	7.2	8.9	9.4
4 ft		24.4	33.9	29.4	43.3	31.1	32.8		35.6			7.2	7.2	9.4
5 ft					33.3		31.7						7.8	

Figure 1. Temperature Monitoring Graphs for Sites 1-4. (*Data in Degrees Celsius)*

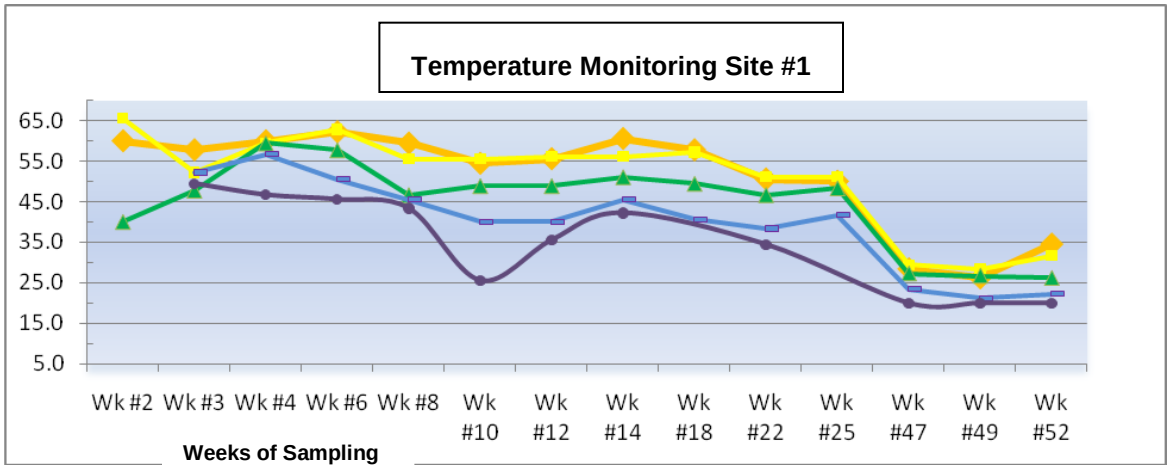
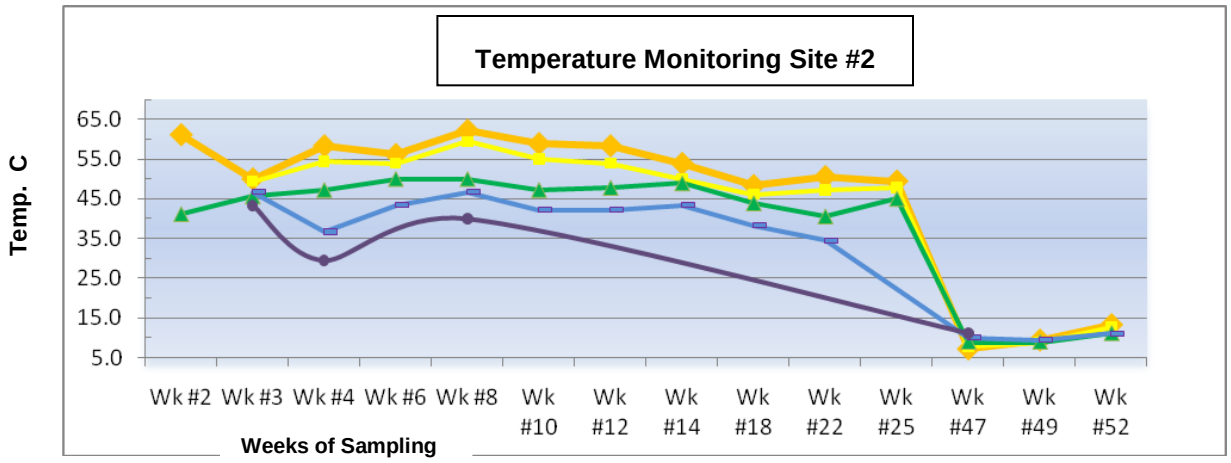
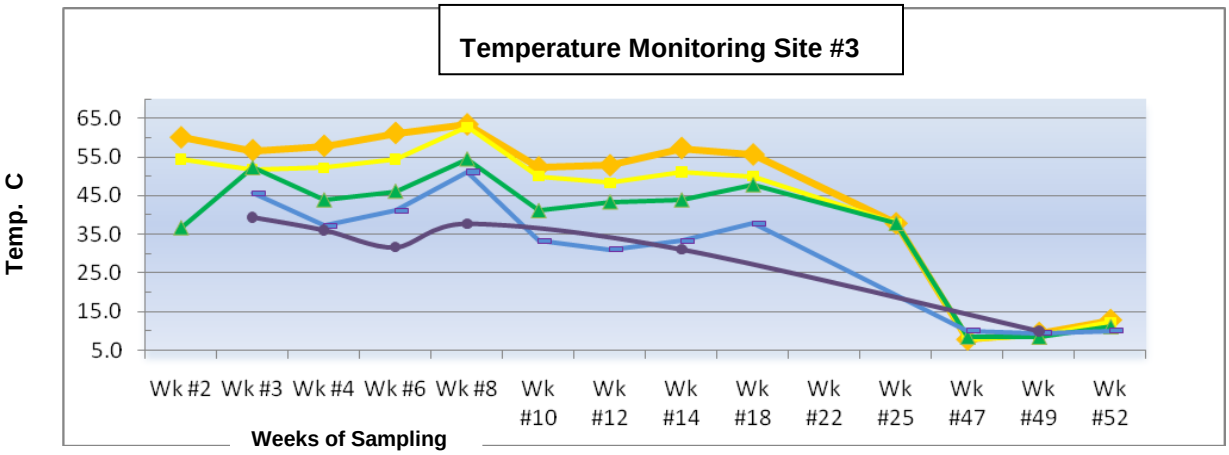


Figure 1. cont.





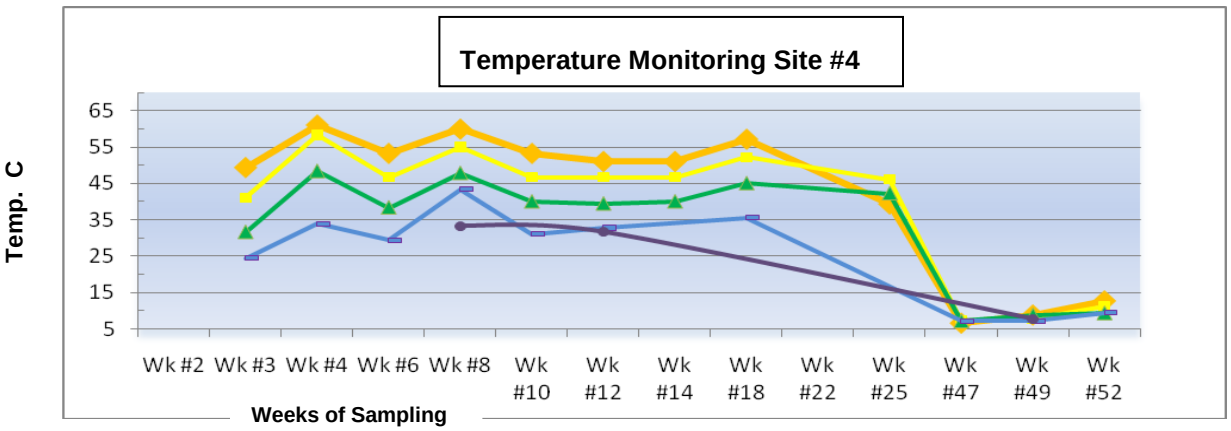


Figure 1. Graph Legend: Depths of Temp. Data

[1 ft] [2 ft] [3 ft] [4 ft] [5 ft]

The data indicate that interior depths of the compost trench did not reach the upper range of optimal composting temperatures (105-145 F) or (40-65 C). Surface layers did reach the optimal range (55-65C) but these layers only contained cover materials. Animal/carcass materials generally occurred at depths of 3 ft (1m) and below. Those samples that did reach the target temperature range at 3-4 ft depth were still at the low end of the target temperature range.

Failure of the compost trench to reach desirable compost temperature is believed to be caused by poor trench aeration and the accumulation of precipitation along the east and south sides of the trench. The soil excavated during the construction of the trench was piled as a berm along the south side of the compost trench. The excess soil used for the berm was not adequately cleared from this area and created standing water during the 2008 growing season. The south side of the trench became saturated during significant rain events and led to reduced aerobic conditions within the trench. The lack of infiltration, due primarily to soil type, and the goal to limit surface runoff from the pile created standing water and seepage of water into the bottom of the trench. By contrast, soil on the north side of the trench adjacent to the crop field was not saturated and did not appear to indicate drainage problems. Poor drainage conditions were not corrected during the 2008 season.

Interior Inspection of Trench

At Week 52 during May, 2009, a test pit was excavated at each of the four temperature monitoring sites to inspect the interior condition of the compost trench and to evaluate the effectiveness of the trench composting technique. Inspection of the interior contents of the pile confirmed the concern represented by the low temperature readings.

The cover material layers at depths of 1-2 ft were moist and friable and uniformly composted. The organic activator and animal carcass layers at depths of 3-5 ft were not well composted. Visual inspection of these materials revealed they were in various stages of decay but it was still possible to distinguish between organic activator materials, rumen contents and flesh/muscle.

Photos of the trench interior are presented in Figures 2 through 7.

Figure 2. Test Pit at Site 1. Distinctive layering of materials in the trench.

Bone materials were not completely decomposed. Marrow material was absent from the outer edges of bones and was easily dislodged from the interior of long bones by tapping on the bone with a tool (rake/shovel) handle. The edges of the bones were brittle and breakable but the middle sections of large bones were still solid and could not be broken or chipped away.

Figure 3. Test Pit at Site 2. (Rumen materials are yellow and flesh materials are pink and gray.)

Figures 4 and 5 show a dark layer of saturated material at approximately 2 ft where surface drainage from standing water saturated the trench. Trench saturation and anoxic conditions were confirmed by the very strong ammonia vapors released from the depths of the test pits. The result of suppressed microbial activity as represented by reduced temperatures in the trench is clearly evident.

Figure 4. Test Pit at Site 3.

Figure 5. Test Pit at Site 3.

Animal remains were clearly evident in test pits 1, 2 & 3. Test pit 4 without animals, the composted materials had more uniform consistency based on the original source materials but were still extremely wet.

Figures 6 and 7 show the color and textural difference of the non-carcass materials at the end of the trench near site 4.

Figure 6. Test Pit at Site 4.

Figure 7. End of Trench near Site 4.

Conclusions and Recommendations

Emergency Response Operation

The Agency of Agriculture considers this emergency response operation successful because the carcasses were removed, contained and the primary public and animal health concerns addressed within three days of when the barn fire occurred. The compost trench and carcasses were not disturbed by scavengers, there were no objectionable odors, potential pathogens were contained and there was no nutrient rich leachate or discharge released from the compost site for the duration of the project.

Problems with the emergency response operation were identified as the limited availability of equipment and personnel to excavate and construct the trench, remove carcasses from the barn and transport them to the compost site and the need to locate an adequate source of base layer and cover materials on short notice after an incident had already occurred. The lack of sufficient equipment and personnel slowed the overall progress of the operation because various tasks could not be completed simultaneously. And finally, Agency of Agriculture personnel were required to conduct part of the operation and operate machinery rather than supervise and/or coordinate operations.

Composting Operation

As a demonstration of the trench composting technique, this project was not as effective as anticipated. Optimal composting temperatures were not achieved. This is primarily attributed to inadequate oxygen supply caused by excess saturation within the trench.

Issues for the technical practice of trench composting require better management of the site to improve surface drainage that was impeded by placement of soil piles and excess weed growth adjacent to the trench. Experience indicates that the area adjacent to a compost trench should remain free and clear of surface obstructions. The site of this compost trench project did have a slight slope (1-2%) that would facilitate good surface drainage if the site had been maintained more carefully.

Based on the internal inspection and excavation conducted at Week 52 during May, 2009, the decision was made that the site was not ready to be plowed and converted back to crop land. The management action for 2009 will be to remove soil berms and weed obstructions to improve drainage so the pile will dry our and to leave the site undisturbed to continue composting for another season.

The option of turning the compost pile and restarting the compost process was considered but not adopted because of the cost required for equipment time and a supply of new cover material. The farm where the compost trench is located was acquired by a new owner and the new land owner does not want to incur these costs. The new land owner is agreeable to hosting the compost project site but does not want to assume management and maintenance duties.

Proposed Modifications to Trench Composting Practice

The Agency of Agriculture proposes modifications to the trench composting practice described by this project. The trench composting techniques as described will be revised to include the addition of tile drainage pipes for the purpose of improving aeration within the trench. Site maintenance requirements for proper drainage and good vegetation control will also be articulated. The Agency of Agriculture is committed to refining this practice and will make use of this composting technique for other situations where circumstances require the disposal of a large number of animal mortalities.

Figure 8 shows how aeration of the shallow trench can be achieved by strategic placement of tile drainage pipes within the compost pile as it is assembled. The revised practice calls for placing a length of tile pipe along each side of the trench after the base layer is placed in the bottom of the trench. A second layer of tile pipe will be placed down the center of the trench after the carcasses and activator layers are in the trench.

All lengths of tile pipes should be fitted with vertical stand pipes for ventilation to open air that would reach above the height of the top cover materials. This configuration will provide for passive aeration of the trench interior. It is anticipated that convective air flow will be enhanced by heating of the pile.

Construction of the trench compost pile in this manner is appropriate for a large number of animals from catastrophic events like fire, floods, roof collapses and storms (depending on the specific geographic threats) but also for animal health and disease outbreaks where on-site burial is often the recommended disposal method. By this approach, on-site containment of disease vectors is still achieved.

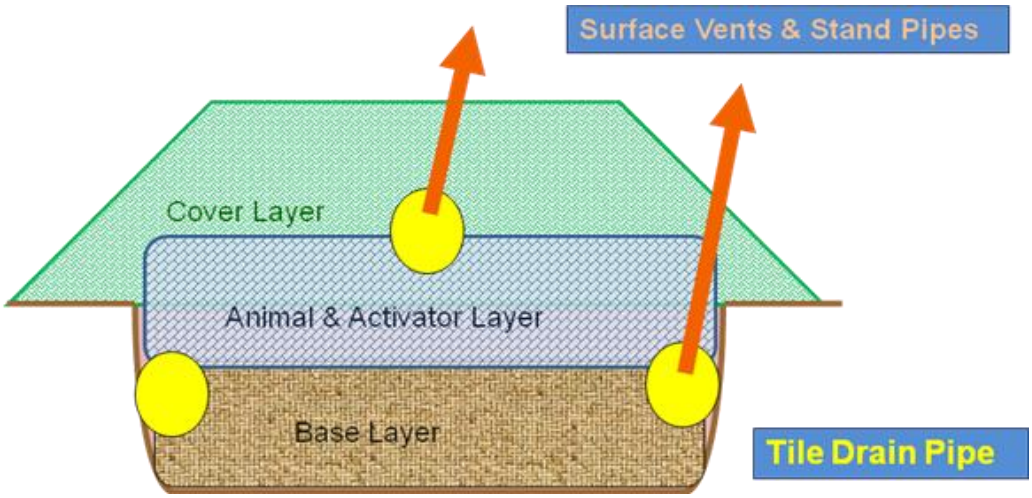


Figure 8. Proposed Design Modification to Trench Composting Practice.

Tile Drain Pipe with Above Ground Air Vents.

Proposed Amendments to Statutory/Regulatory Authority

The complications of this incident highlighted the need for animal/public health and safety agencies (or other emergency response management entities) to obtain direct reimbursement and recoup costs for third party providers of goods and services as the result of responding to and remediating emergency situations.

The Agency of Agriculture discovered a deficiency in the statutory powers of the Secretary of Agriculture in the aftermath of this project. To remedy this identified shortcoming, the Agency of Agriculture has drafted proposed legislation to provide the Agency the necessary authority to respond to and remediate incidences of mass animal death or other emergency situations with the goal to avert the threat of a public health hazard. The proposed legislation also provides the Secretary of Agriculture with authority to establish a lien and seek reimbursement of costs from insurance payments and other sources of compensation that land owners may be entitled to, when expenses are incurred resulting from emergency response and remediation activities on the behalf of a landowner.

This proposed regulatory authority would be added to the General Powers provisions for the Secretary of Agriculture under 6 V.S.A. Chapter 1.

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